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Letter
Circular
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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON 25, D. C.

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Accuracy and Precision
of
Calibrated Values
for
Standard Weights of the Laboratory Classes

This Letter Circular has been prepared to give information about the extension of the weight calibration service to include standards for quartz microbalances and similar instruments, and about the increased accuracy and precision of values under the laboratory classes of standards.

In response to the need for standard microbalance weights to be used in the calibration of quartz torsion microbalances or similar instruments the weight calibration service of the Bureau has been extended to include the calibration of small weights of special design to a precision of 0.0001 mg or 0.0002 mg, depending on whether the weights are in a series that can be readily intercompared.

Classification for Laboratory Weights

This Bureau has established four classes under which weights for laboratory use may be standardized. They are Classes M, S, S2, and Microbalance Weights. The chief characteristics of these classes are briefly as follows:

Specifications for Class M weights require that they be strictly of one piece, and otherwise suitable for reliable reference standards, or for weighings of extreme precision, or for weighings over a period of time necessitating a high degree of constancy of the standards. Values may be determined under either the Moderate Precision or the High Precision Calibration. (See the Following tabulation of accuracy) Since volumetric determination by hydrostatic weighing for the larger weights is a required part of the High Precision Calibration two piece weights are necessarily excluded.

Weights of both Class S and Class S2 may be of the common screw-knob type. Class S weights must show a reasonable degree of constancy with changes in atmospheric humidity. The use of lead or other variable adjusting material is specifically prohibited. Under Class S values may be determined under either the Tolerance Test or the Class S Calibration. Under a tolerance test weights may be certified as accurate if the errors do not exceed the specified tolerances. Under Class S2 weights are certified only as being correct within the specified tolerances which are five times the Class S tolerances.

Microbalance Weights include weights especially designed for use with quartz microbalances or similar instruments. Weights may be of platinum-iridium, platinum, tantalum, or other highly constant material and should be made with as small a surface as is practicable. Special attention must be given to avoid rough or sharp edges. Surfaces should be well polished. The usual Class M aluminum weights from 20 mg to 1 mg are not sufficiently constant for this class.

Weights of odd denomination may be submitted for calibration with an accuracy of 0.0002 mg. No tolerances apply to these weights. In the case of weights intended to be intercompared in a series with an accuracy of 0.0001 mg they should be accurately adjusted to within 0.003 mg of their nominal values.

Precision

Values of calibrated weights ordinarily include one doubtful figure. Values are rounded off to one less decimal place when the certified accuracy amounts to 15 or more in the unrounded value. An exception is made in the case of Class S weights below 1 g with values accurate to 0.01 mg and rounded off to 0.01 mg. In this case the values are ordinarily used in computations of 0.1 mg or some larger amount and the weights need not be constant to much better than 0.01 mg.

Accuracy of Class S Calibration

Three parts per million for weights 10 g and above

0.03 mg	"	"	10 g to 1 g
0.01 mg	"	"	below 1 g

0.01 mg for 1 g standards of platinum, tantalum, gold or similar materials.

Accuracy of Class M Moderate Precision Calibration

Three parts per million for weights 10 g and above

0.03 mg	"	"	10 g to 1 g
0.003 mg	"	"	below 1 g

0.01 mg for 1 g standards of platinum, tantalum, gold or similar materials.

Accuracy of Class M High Precision Calibration

One part per million for weights 10 g and above

0.01 mg	"	"	10 g to 1 g
0.001 mg	"	"	below 1 g

Accuracy of Calibration of Microbalance Standards

0.0001 mg for standards below 100 mg provided the weights are of a nominal value which can be readily intercompared with a series of weights.

0.0002 mg for standards of denominations not readily intercompared.

Fees

The improvements in accuracy under Classes M and S are offered without increasing the fees for weights of 200 g or smaller. Amendments to NES Circular 483 provide for increased fees for weights above 200 g and provide a new fee schedule for Microbalance Weights. Fee schedules will be supplied on request.

Priority

Delays of several months may occur with work which does not qualify for priority. Priority is assigned to material submitted as standards to be used in precision research or testing, in the production of new standards, and in law enforcement.

Statements establishing the need for priority should originate in the laboratory in which the weights are to be used.

In the case of request for the High Precision Calibration under Class M, priority will not be assigned until the need for this accuracy is clearly established. The increased accuracy offered under the Class S calibration and the Class M Moderate Precision Calibration is expected to extend their usefulness to include much work which previously has required the High Precision Calibration.

For example, if the work requires detailed air buoyancy corrections derived from the actual volumes of the weights the High Precision Calibration is clearly indicated. It may also be required in other cases. In the case of assay sets, values under the Class M Moderate Precision Calibration with accuracy within 0.003 mg and a precision of 0.001 mg below 1 g are accurate enough for most assay work. Values are certified under Class S and under Class M Moderate Precision are adequate for most of the work of adjusting values of new weights within prescribed tolerances.

Shipment

A letter listing all items and the work required should precede shipments so that the material can be identified upon arrival. The letter should be signed by some one authorized to obligate funds; or, preferably, a purchase order should be enclosed.

Material should be packed with care. Storage cases for weights are often not designed as shipping cases. Unless the cases are designed so as to hold the weights securely in place during shipment, weights larger than about 200 g should be shipped separate from the case individually wrapped in several thicknesses of tissue paper followed by several layers of a soft material such as cloth or cotton wadding followed by strong wrapping paper to exclude rough packing material commonly used in shipping boxes. Smaller cases often need extra material inside to hold the weights in place or to hold the cover in place over sheet metal fractional weights.

Shipping charges to the Bureau are to be prepaid. Return shipments are regularly made by express, collect. Since certified weights are packed in sealed packages they are not acceptable for parcel post shipment. Government bills of lading, when required for return shipment, should be included with the original request.

Tolerances and Accuracy for Laboratory Weights

Classes M, S and S2**

Denomination	Tolerances		Accuracy of Calibration		
	Class S and		Class M	Moderate	High
	Class S2	Class M		Precision	Precision
	mg	mg	mg	mg	mg
20 kg	500	100	60	60	20
10 kg	250	50	30	30	10
5 kg	150	30	15	15	5
3 kg	75	15	9	9	3
2 kg	50	10	6	6	2
1 kg	25	5	3	3	1
500 g	15	3	1.5	1.5	0.5
300 g	10	2	0.9	0.9	0.3
200 g	5	1	0.6	0.6	0.2
100 g	2.5	0.5	0.3	0.3	0.1
50 g	1.5	0.3	0.15	0.15	0.05
30 g	1.0	0.2	0.09	0.09	0.03
20 g	1.0	0.2	0.06	0.06	0.02
10 g	0.75	0.15	0.03	0.03	0.01
5 g	0.75	0.15	0.03	0.03	0.01
3 g	0.50	0.10	0.03	0.03	0.01
2 g	0.50	0.10	0.03	0.03	0.01
1 g	0.50	0.10	0.03*	0.03*	0.01
500 mg	0.25	0.05	0.01	0.003	0.001
300 mg	0.25	0.05	0.01	0.003	0.001
200 mg	0.25	0.05	0.01	0.003	0.001
100 mg	0.25	0.05	0.01	0.003	0.001
50 mg	0.15	0.03	0.01	0.003	0.001
30 mg	0.15	0.03	0.01	0.003	0.001
20 mg	0.15	0.03	0.01	0.003	0.001
10 mg	0.10	0.02	0.01	0.003	0.001
5 mg	0.10	0.02	0.01	0.003	0.001
3 mg	0.10	0.02	0.01	0.003	0.001
2 mg	0.05	0.01	0.01	0.003	0.001
1 mg	0.05	0.01	0.01	0.003	0.001

* In the case of 1 g standards of such materials as platinum, tantalum, or gold the accuracy may be 0.01 mg.

** For the class of Microbalance Standards which includes weights below 100 mg especially designed for quartz torsion microbalances or similar instruments: (a) for weights of nominal values that can be readily intercompared in a series, accuracy 0.0001 mg, tolerance 0.003 mg; (b) for weights of denominations not readily intercompared, accuracy 0.0002 mg, no tolerance specified.

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